Wiring Handbook

Contents

Introduction

This document defines a telecommunications wiring system for State of Montana Agencies, offices or buildings. These guidelines are to be used as a means to provide minimum requirements. Specific requirements for each project will be coordinated with the using agency and State Information Technology Services (STISD), during project development. STISD is the State of Montana Agency responsible for the maintenance, repair, and installation of all State of Montana network cable. Therefore, all requests to repair, move, or install such cable for all State of Montana Agencies must be submitted to STISD.

These guidelines are based on industry standards from The Electronics Industry Alliance (EIA) and the Telecommunications Industry Association (TIA). These standards detail the architecture, engineering, cable specification, and management of cabling systems. Proper adherence to these guidelines will reduce long-term building operation costs by providing a better infrastructure adaptable to change.

Acronyms and Abbreviations

EIA/TIA	Electronics Industries Association/ Telecommunications Industries Association
EMI	Electromagnetic Interference
FDDI	Fiber Distributed Data Interface
IC	Intermediate Cross-connect
LAN	Local Area Net
MC	Main Cross-connect
TC	Telecommunications Closet
UTP	Unshielded Twisted Pair
WAN	Wide Area Net

Specifications

Horizontal Wiring

The horizontal wiring is the portion of the telecommunications wiring systems that extends from the area outlet to the telecommunications closet. This includes the termination at the outlet as well as the termination and cross connects at the closet.

The horizontal wiring should be a star topology, meaning each work area outlet must be directly connected to a telecommunications closet. The maximum horizontal distance should not exceed 300' from the outlet to the closet (See Figure 1). Installations should make an allowance of approximately 20' for the patch cables in the wire closet and outlet end because the total length from the equipment in the telecommunications closet and the devise on the end cannot exceed 328' total.

A minimum of two telecommunications outlets should be provided for each individual work area. A 4-pair UTP CAT5e solid PVC or plenum cable should support both outlets. Whether plenum or PVC cable depends on where the cable runs. PVC cable features an outer jacket that gives off toxic fumes when it burns. It's commonly used in runs from the wiring closet to the wall plate, but only if the building features a contained ventilation system running through duct work. Plenum cable has a special coating, which does not give off toxic fumes when it burns. A plenum is a space within a building created by building components designed for the movement of environmental air. Each of these outlets may be used for either voice and/or data.

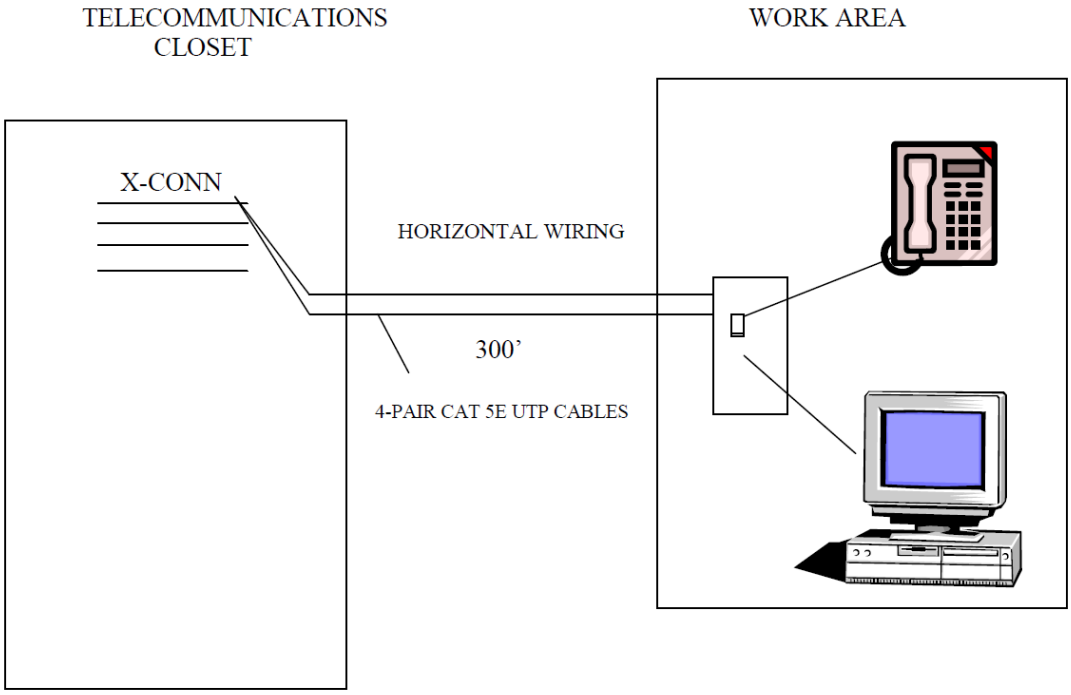


Figure 1 - Typical Horizontal and Work Area Wiring

Installation

Category 5E (CAT5e) wiring requires special installation practices. Pair twisting, for instance, is one of the critical physical characteristics of the cable that affects near-end cross talk performance. As a result, the EIA/TIA Standard requires that the pair twist be maintained to within one-half inch of the termination point on each end of the cable. This requirement is imposed to minimize untwisting of wire pairs and the separation of conductors within a pair.

The State of Montana wiring standards call for special termination practices when terminating CAT5e cable to ensure LAN speeds of up to 1 gigabit to ensure users get the most of their local area network. When placing cables adhere to the following:

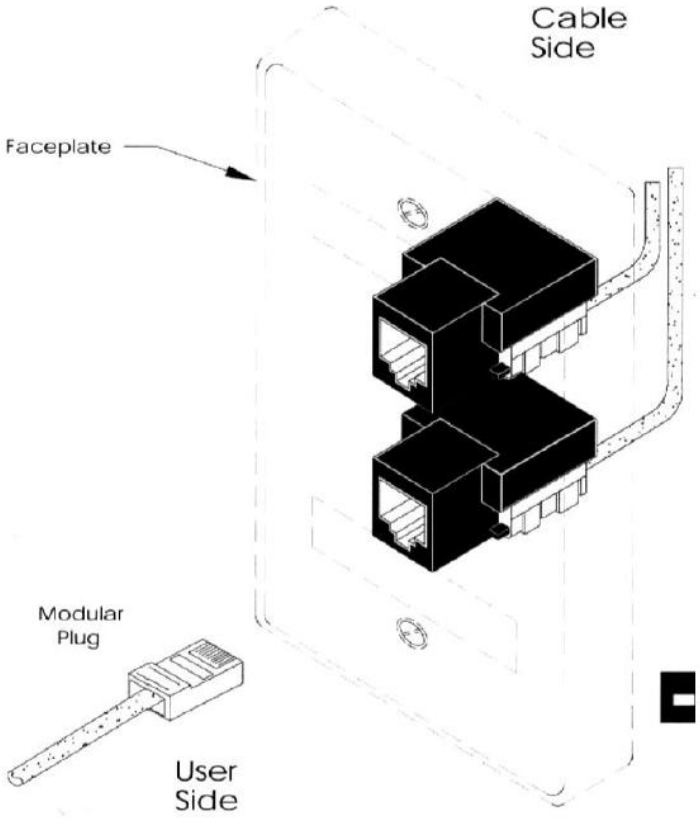
- Use a minimum bend radius of ten times the cable diameter equivalent to placing data wire around a 1" conduit.
- Follow building and fire codes penetrations made during routing of cable through firewalls. Firewalls must be sealed with fire stop materials. This stops the flow of smoke, flames, toxic fumes and etc.
- Avoid routing cables near electro-magnetic interference noise sources, such as motors and power lines. Hangers are necessary to support the cable above fluorescent fixtures and other sources, which can induce noise on the cable.
- Use the same cable throughout. Do not mix cabling from different manufacturers.
- Avoid coiling cables. This can lead to degradation of performance.
- Cable ties should be applied with just enough tension to hold the cables in place, but not tightly enough to squeeze the cables. Also space the ties randomly.
- Cables must be supported at a maximum of 5' intervals and cannot be attached to electrical conduit, heating or plumbing hardware or ceiling grid wires.

Work Area (Outlet Location)

The work area components extend from the telecommunications outlet end of the horizontal wiring system to the station equipment. The station equipment can be any of a number of devices including telephones, fax machines, and personal computers.

Work area wiring may vary in form depending on the application. A cord with identical connectors on both ends often is used. The State of Montana wiring standards calls for a CAT5e stranded patch cord when the application is a LAN data device.

ANSI/TIA-568C.1-1, which is the governing standard regarding commercial cabling systems limits the length of patch cables to 10 m in total length. These 10 m of total length include both the work area and telecommunications closet patch cords. When adaptations are needed they should be external to the telecommunications outlet. Each 4-pair cable should be terminated in an eight-position CAT5e modular jack as shown in the example (See Figure 2).



2.3.1.1.1.1.1 **T568A**

Pin #	Conductor Color Code
1	white/green
2	green
3	white/orange
4	blue
5	white/blue
6	orange
7	white/brown
8	brown

Figure 2 - Eight-Position Jack Pin/Pair Assignments (Designation T568A)

Telecommunications Closet

A telecommunications closet is an area within a building set aside for the exclusive purpose of housing equipment associated with the telecommunications wiring system. Every building should contain at least one telecommunications closet or equipment room.

The telecommunications closet should contain the mechanical terminations for a portion of the horizontal wiring system and a portion for the backbone wiring system. In this usage, the telecommunications closet should provide facilities (space, power, grounding, etc.) for passive (cross-connect), active devices, or both used to interconnect two systems.

Labeling

Each telecommunications outlet should have a label placed on the faceplate or cover of the jack; this is to identify the outlet for record keeping as well as for maps or floor plans. Each label will contain the xx-yyy identifier. The xx is the number of the patch panel that the particular outlet is terminated in. The yyy is the number of the outlet.

Example: Patch Panel A, Position 24 **A-24**

Testing

Testing is critical. Test results should be evaluated, using the most up-to-date criteria from the TIA/EIA Standard, and the result shown is pass/fail. Test results should be printed directly from the test unit or from a download file using an application from the test equipment manufacturer. The test results should include all tests performed, the expected test result and the actual test result achieved. All CAT5e field testing should be performed with approved equipment (tester) and should comply with the accuracy requirements for level IIe field testers as defined in ANSI/TIA-1152. Each new cable that is placed should be tested and certified for:

- Wire map,
- Length,
- Insertion Loss
- Near End Crosstalk (NEXT),
- Power Sum Near End Crosstalk (PSNEXT),
- Attenuation to Crosstalk Ratio Far End(ACR-F),
- Power Sum Attenuation to Crosstalk Ratio Far End(PS ACR-F),
- Return Loss (RL),
- Propagation Delay,
- Delay Skew.

Backbone Wiring

The function of the backbone wiring is to provide interconnection between telecommunications closets, equipment rooms and entrance facilities in the telecommunications wiring system structure. Typically multi-pair cable and/or fiber optics cable are used as backbone cables.

The backbone wiring should use the conventional hierarchical star topology where in each telecommunications closet is wired to a main cross-connect or an intermediate cross-connect then to a main cross-connect.

Backbone wiring defined by this standard is applicable to a range of different user requirements. Depending upon the characteristics of the individual application, choices with respect to transmission media have to be made. In making this choice, factors to be considered include:

- Flexibility with respect to supported services,
- Required useful life of backbone wiring,
- Site size and user population.

Cabling System Technical Specification Enhanced Category 5 UTP

Introduction

Purpose. The intent of this section is to provide a standard specification that will be used for all State of Montana facilities requiring cabling installation. This section provides the minimum performance criteria for the components and sub-systems comprising a complete cabling system. Product specifications, general design considerations, and installation guidelines are provided in this written document. Quantities of telecommunications outlets, typical installation details, cable routing, and outlet types for a State facility will be provided as an attachment to this document. If the bid documents are in conflict, the written specification should take precedence. The successful vendor should meet or exceed all requirements for the cabling system described in this document.

The Customer's Cable Infrastructure Project requires a Siemon structured cabling system, or equivalent single-manufacturer solution. The Enhanced Category 5 portion of the cabling system should comply with the link and channel performance requirements of ANSI/TIA/EIA 568-B.

The successful contractor is required to furnish all labor, supervision, tooling, miscellaneous mounting hardware and consumables for each cabling system installed.

Quality Assurance

Contractor Qualifications

The contractor should at a minimum possess the following qualifications:

- Be in business a minimum of three (3) years.
- Demonstrate satisfaction of sound financial condition and can be adequately bonded and insured if the project deems necessary.
- Possess licenses/permits required to perform telecommunications installations in the specified jurisdiction.
- Obtain/have/possess personnel knowledgeable in local and state codes and regulations. All work should comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations should be followed.
- Possess current liability insurance certificates.
- Have personnel fluent in the use of Visio or Computer Aided Design and possess and operate Visio or CAD software using Microsoft. Visio drawing or DWG or .DXF format.

The contractor should own and maintain tools and equipment necessary for successful installation and testing of optical and CAT5e metallic premise distribution systems.

Required Contractor Training.

The contractor should be fully conversant and capable of cabling low voltage such as, but not limited to, data, voice, and imaging network systems.

The contractor should at a minimum possess the following qualifications:

- Personnel trained and certified in the design of a structured cabling system.
- Personnel trained and certified to install a structured cabling system.
- Provide references of the type of installation provided in this specification.
- Personnel trained and certified in fiber optic cabling, splicing, termination and testing techniques. Personnel must have experience using a light meter and OTDR.
- Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.

Contractor Responsibility.

The contractor should be obligated to exercise the highest standard of care in performing its obligations. The contractor acknowledges that the State of Montana relys on contractor's expertise, ability, and knowledge of the system and thus the contractor is obligated to exercise the highest of standard care in performing its obligations.

Manufacturer Quality & Product Substitutions.

All telecommunications connecting hardware and cable must be made by an ISO 9001:2000 Certified Manufacturer. All products must meet the technical requirements listed in this document. Any products not meeting these requirements will not be considered.

Industry Requirements

The following installation, documentation, component, and system industry specifications should be met or exceed:

- ANSI/TIA/EIA-568-B.1 and addenda "Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements,"
- ANSI/TIA/EIA-568-B.2 and addenda "Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair,"
- ANSI/TIA/EIA-568-B.3 and addenda "Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling and Components Standard,"

- ANSI/TIA/EIA-569-B and addenda ” Commercial Building Standard for Telecommunications Pathways and Spaces,”
- ANSI/TIA/EIA-606-A and addenda ” Administration Standard for the Telecommunications Infrastructure of Commercial Buildings,”
- ANSI-J-STD-607-A and addenda ” Commercial Building Grounding and Bonding Requirements for Telecommunications,”
- ANSI/TIA/EIA-526-7 ”Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant,”
- ANSI/TIA/EIA-526-14A ”Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant,”
- IEC/TR3 61000-5-2 - Ed. 1.0 and amendments “Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling,”
- ISO/IEC 11801:2002 Ed2.0 and amendments ” Information technology - Generic cabling for customer premises,”
- CENELEC EN 50173:2000 and amendments “Information Technology - Generic cabling systems.”

System Design Requirements

Horizontal Cabling. The Horizontal subsystem is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the telecommunications room. It consists of the telecommunications outlet/connector, the horizontal cables, optional consolidation point, and that portion of the cross-connect in the telecommunications room serving the horizontal cable.

Backbone Cabling. Cables allowed for use in the backbone include: 4-pair 100 balanced twisted-pair copper, multi-pair 100 balanced twisted-pair copper, hybrid or bundled 100 balanced twisted-pair copper, 50/125m or 62.5/125m multimode optical fiber, and 8.7-10m single mode optical fiber cables. The cable should support voice, data, and imaging applications. The bending radius and pulling strength requirements of all backbone cables should be observed during handling and installation.

Intra-building Cabling. The cable route within a building, connecting closet to closet or closet to the equipment room is referred to as the Intra-building Backbone Subsystem. It links the Main Cross-connect (MC) in the equipment room to Intermediate Cross-connects (IC) and Horizontal Cross-connects (HC) in the Telecommunications Rooms (TR). It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media.

Inter-building Cabling. When a distribution system encompasses more than one building, the components that provide the link between buildings constitute the Inter-building Backbone Subsystem. This subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or high voltage power surges that pass through the building cable. It is normally a first-level backbone cable beginning at the MC in the equipment room of the hub building and extending to the IC in the equipment room of a satellite building.

Telecommunications Room. The HC should consist of either a rack or wall mounted wiring blocks or panels for termination of copper cables or rack or a wall mount interconnect centers or fiber management panels/trays for the termination of optical fibers. Cross-connect spaces include the labeling of hardware for providing circuit identification and patch cords or cross-connect wire used for creating circuit connections at the cross-connect. The telecommunications room should be equipped to contain telecommunications equipment, cable terminations, and associated cross-connects. Separation from sources of EMI should be in accordance with ANSI/TIA/EIA-569-A and local code.

Communication grounding / earthing and bonding should be in accordance with applicable codes and regulations. It is recommended that the requirements of IEC/TR3 61000-5-2 - Ed. 1.0, ANSI-J-STD-607-A, or both be observed throughout the entire cabling system. The telecommunications room should be dedicated to the telecommunications function. Access to telecommunications rooms should be restricted to authorized service personnel and should not be shared with building services that may interfere with the telecommunications systems or be used for building maintenance services.
Lighting in the telecommunications room should be a minimum of 500 lx (50 foot candles) at the lowest point of termination. The light switch should be easily accessible when entering the room.
A minimum of two dedicated duplex or two dedicated simplex electrical outlet, each on a separate circuit, should be provided for equipment power. Additional convenience duplex outlets should be placed at 1.8 m (6 ft) intervals around the perimeter walls.

Installation

Site Survey. Prior to placing any cable pathways or cable, the contractor should survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Arrangements to remove any obstructions will be determined with the project manager need to be determined at that time.

Physical Installation.

Cable Pathways. Pathways should be designed and installed to meet applicable local and national building and electrical codes and regulations. Grounding / Earthing and bonding of pathways should comply with applicable codes and regulations. Pathways should not have exposed sharp edges that may come into contact with telecommunications cables. The number of cables placed in a pathway should not exceed manufacture specifications, nor, will the geometric shape of a cable be affected. Pathways should not be located in elevator shafts. If a J-hook or trapeze system is used to support cable bundles all horizontal cables should be supported at a maximum of five-foot intervals - at no point should cable(s) rest on acoustic ceiling grids or panels. Cables should be installed above fire-sprinkler and systems and should not be attached to the system or any ancillary equipment or hardware.

Intra-building Cable Routing. The backbone subsystem should include cable installed in a vertical manner between floor telecommunications rooms and the main or intermediate cross-connect in a multi-story building. Cable installed horizontally between telecommunications rooms and the main or IC in a long single story building like a school or factory.
Unless otherwise recommended by the manufacturer, all fiber cables will be run in innerduct.

Fibers should be terminated in the telecommunications rooms using SC, ST, MT-RJ, or LC connectors in either wall mounted interconnect centers or rack mounted panels equipped with sufficient ports, slack storage space, and splice trays.

Adequate riser sleeve/slot space should be available with the ability to ingress the area at a later date in all telecommunications rooms, such that no drilling of additional sleeves/slots is necessary.

The backbone cables should be installed in a star topology, emanating from the MC to each telecommunications room. An IC may be present between the MC and the HC. This is known as a hierarchical star topology.

At least one 4-pair balanced twisted-pair, hybrid/bundled, or multi-pair cable should be run for each intra-building backbone segment.

Optical fiber should be run for any backbone segment greater than 90 m (295 ft.). If the intra-building backbone segment is less than 90 m (295 ft.), and fiber is not routed, the balanced twisted-pair cable should be CAT5e or higher. Backbone pathways should be installed or selected such that the minimum bend radius of backbone cables is kept within manufacturer specifications both during and after installation.

Inter-building Cable Routing. The backbone subsystem should include cable installed between buildings via underground, tunnel, direct -buried, aerial or any combination of these from the MC to an IC in a multi-building campus. Unless otherwise recommended by the manufacturer, all fiber cables will be run in innerduct. Fibers should be terminated in the telecommunications rooms using SC, ST, MT-RJ or LC connectors either in wall mounted interconnect centers or rack mounted panels equipped with sufficient ports, slack storage space and splice trays.

In an underground system, adequate underground conduit space should be available and accessible at each building. The conduits should not exceed a fill factor of 40%.

All underground systems should be designed to prevent water runoff from entering the building.

The backbone cables should be installed in a star topology, emanating from the MC to each satellite building telecommunications room. All inter-building cables should be installed to the applicable codes and regulations.

Optical fiber should be run for all inter-building backbone segments, and as a recommendation, at least one balanced twisted-pair cable should be run for each inter-building backbone segment.

Backbone pathways should be installed or selected such that the minimum bend radius and pulling tension of backbone cables is kept within cable manufacturer specifications both during and after installation.

Horizontal Cable Routing. All horizontal cables, regardless of media type, should not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the HC horizontal cross connect. The combined length of jumpers, or patch cords, and equipment cables in the telecommunications room and the work area should not exceed 33 ft. unless used in conjunction with a multi-user telecommunications outlet. Two horizontal cables should be routed to each work area. At least one horizontal cable connected to an information outlet should be 4-pair, 100 balanced twisted-pair.

It is recommended that a minimum horizontal cable distance of 49 ft. should be maintained between the telecommunications room and the work area.

For installations with consolidation points, a minimum horizontal cable distance of 49 ft. should be maintained between the telecommunications room and consolidation point, and 16 ft. between the consolidation point and the work area. Horizontal pathways should be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.

In open ceiling cabling, cable supports should be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports should be spaced no more than 5 ft. apart.

Telecommunications pathways, spaces and metallic cables, which run parallel with electric power or lighting, which are less than or equal to 480 Vrms, should be installed with a minimum clearance of 2 in. The installation of telecommunications cabling should maintain a minimum clearance of 3 m (10 ft) from power cables in excess of 480 Vrms.

No telecommunications cross-connects should be physically located within 20 ft. of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms.

For voice or data applications, 4-pair balanced twisted-pair or fiber optic cables should be run using a star topology from the telecommunications room serving that floor to every individual information outlet.

The contractor should observe the bending radius and pulling strength requirements of the 4-pair balanced twisted-pair and fiber optic cable during handling and installation.

Each run of balanced twisted-pair cable between horizontal portions of the cross-connect in the telecommunication closet and the information outlet should not contain splices.

In a false ceiling environment, a minimum of 3 inches should be observed between the cable supports and the false ceiling.

Continuous conduit runs installed by the contractor should not exceed 100 ft. or contain more than two 90 degree bends without utilizing appropriately sized pull boxes.

All horizontal pathways should be designed, installed and grounded to meet applicable local and national building and electrical codes. The number of horizontal cables placed in a cable support or pathway should be limited to a number of cables that will not cause a geometric shape of the cables. Maximum conduit pathway capacity should not exceed a 40% fill. However, perimeter and furniture fill is limited to 60% fill for moving and changes. Horizontal distribution cables should not be exposed in the work area or other locations with public access.

Cables routed in a suspended ceiling should not be draped across the ceiling tiles. Cable supports should be mounted a minimum of 3 in above the ceiling grid supporting the tiles.

Work Area Termination. All balanced twisted-pair cables wired to the telecommunications outlet/connector should have 4-pairs terminated in eight-position modular outlets in the work area.

Termination 568A. Voice jacks in horizontally oriented faceplates should occupy the left-most position(s). Data jacks in horizontally oriented faceplates should occupy the right-most position(s).

The telecommunications outlet/connector should be securely mounted at planned locations.

The height of the telecommunications faceplates must conform to applicable codes and regulations.

Pulling Tension. The maximum cable pulling tensions should not exceed manufacturer's specifications.

Bend Radius. The maximum cable bend radii should not exceed manufacturer's specifications. In spaces with balanced twisted-pair cable terminations, the maximum bend radius for 4-pair cable should not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This should be done unless this violates manufacturer's specifications.

Slack. In the work area, a minimum of 12 in should be left. for balanced twisted-pair cables, while 3 ft. for fiber cables. In telecommunications rooms a minimum of 10 ft. of slack should be left. for all cable types. This slack must be neatly managed on trays or other support types.

Cable Tie Wraps. Tie wraps should be used at appropriate intervals to secure cable and to provide strain relief at termination points. These wraps should not be over tightened to the point of deforming or crimping the cable sheath. Hook and loop cable managers should be used in the closet where reconfiguration of cables and terminations may be frequent.

Grounding. All grounding / earthing and bonding must conform to applicable codes and regulations.

Fire Protection. Properly installed firestop systems should be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways. Fire stops conform to applicable codes and regulations.

Workmanship. All work should be done in the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

Balanced Twisted-Pair Product Specifications

In addition to meeting the CAT5e specifications outlined in ANSI/TIA/EIA-568-B.2, The requirements in this section must also be met for all applicable balanced twisted-pair products as listed below.

Outlets. All CAT5e information outlets designed for termination of 4-pair balanced twisted-pair CAT5e copper cable must possess the following characteristics at the minimum:

- Be independently verified for category 5e component compliance to 200 MHz.
- Have available gravity feed (45 degree angled) low profile as well as flush mount design.
- Utilize tri-balance technology with optimized pair balance design and linear crosstalk response to address applications up to 160 MHz.
- Have 310 style insulation displacement connectors with quadrant pair isolation and a pyramid wire entry system. Termination is accomplished with a single conductor impact tool.
- Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
- Have rear protective strain relief caps with side or rear entry, which can be installed onto cable before or after termination.

- Support industry standards for T568A on each individual outlet.
- Allow installation from the front or rear of the faceplate, and allow for the jack to pass through the faceplate without re-termination.
- Be side-stackable for high-density solutions.
- Have a color matching, protective, hinged, or flexible door to protect the outlet from dust and other airborne contaminants.
- Provide color-coded, slide-in icons available for circuit identification.
- Be constructed of high impact, flame-retardant thermoplastic.
- Have, as an option, an outlet, which can be mounted into an IEC 60603-7 compliant opening (keystone).
- Must be certified by Underwriters Laboratories to United States Standards.
- Meet the following performance specifications:

Margin over category 5e @ 160MHz		
Parameters	**Worst Case**	**Typical**
Insertion Loss (dB)	0.12	0.14
NEXT* (dB)	2.20	3.54
FEXT* (dB)	8.38	8.86
Return Loss (dB)	8.58	14.92

* Tested in both Differential and Common modes

Siemon Company MAX 5e Modules or equivalent recommended

Patch cords. All CAT5e modular equipment cords should be:

- 100% transmission tested with laboratory grade network analyzers for proper performance.
- Utilizing stranded cable within a round, flame-retardant jacket.
- Backwards compatible with lower performing categories.
- Equipped with modular 8-position plugs on both ends, wired straight through with standards compliant wiring.

- Utilizing modular plugs, which, exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro-inches minimum of gold plating over nickel contacts.
- Resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.
- Available with red and blue jackets.
- Available in standard lengths of 3,4, 5, 6,7,8,10, 15, and 20 ft. with custom lengths available upon request.
- Meeting or exceeding TIA/EIA and ISO/IEC CAT5e electrical performance.
- Certified by Underwriters Laboratories to United States Standards.
- Utilize stranded cordage that meets the following performance specifications:

Frequency (MHz)	**Insertion Loss (dB/100m)**	**PS NEXT (dB)**
1	2.4	62.3
4	4.9	53.3
10	7.8	47.3
16	9.9	44.3
20	11.1	42.8
31.25	14.1	39.9
62.5	20.4	35.4
100	26.4	32.3

Patch panels. All termination panels should facilitate cross-connection and inter-connection using modular patch cords and should conform to EIA standard, 19 inch relay rack mounting requirements. They should:

- Allow the use of the same modular outlets used in the work area.
- Be made of black, lightweight, high strength brushed aluminum in 16-, 24-, and 48-port configurations.
- Allow the use of other multimedia outlets including optical fiber and coaxial.
- Have openings, which allow terminated jacks to pass through panel for easy rearrangement.

- Have port identification numbers on both the front and rear of the panel.
- Accommodate at least 24 ports for each rack mount space (1RMS = 44.5 mm [1.75 in.]).
- Be available with an integrated rear wire management bar.

Siemon MAX Series Patch Panel or equivalent recommended

Connecting Blocks. The connecting block should facilitate cross-connection and/or inter-connection using patch cords. The 66 blocks should possess the following characteristics:

- Be made of high-impact, flame-retardant thermoplastic.
- Be available in 4x50-pair size to support up to 12 4-pair balanced twisted-pair cables.
- Have optional colored, hinged covers for protection and designation available in white, red, gray, yellow, blue, green, violet, orange, and brown.
- Have mounting features to allow direct wall mounting, bracket mounting ,or 19" panel mounting via optional frame.
- Incorporate fanning strips on each side of block for management of horizontal cabling and cross-connect (jumper) wires, as well as providing a labeling surface for circuit identification.
- Have available accessories to include standoff-brackets, organizer rings, clear snap-on covers, designation strips, and a CAT5e modular test adapter .
- Have connecting blocks with a minimum of 200 re-terminations without signal degradation below standards compliance limit.
- Support wire sizes: solid insulated 22-26 AWG (0.64 mm - 0.40 mm) or solid stripped 18-19 AWG (1.02 – 0.91mm).
- Meet or exceed TIA/EIA and ISO/IEC CAT 5e component specifications.
- Must be Communications Circuit Accessory Listed per Underwriters Laboratories Standard UL 1863 .

Siemon S66 Wiring Blocks or equivalent recommended

Cable

Twisted Pair Cabling. All qualified cables should exceed the most severe requirements by the worst case margins listed below for all specified frequencies (except where noted):

Parameter	**Margin 1-100 MHz (over Category 5e)**	**Performance @ 100 MHz**
Insertion Loss	0 %	22.0 dB

NEXT	0 dB	35.3 dB
PSNEXT	0 dB	32.3 dB
ACR	-	13.3 dB
PSACR	-	10.3 dB
ELFEXT	0 dB	23.8 dB
PSELFEXT	0 dB	20.8 dB
Return Loss	0 dB	20.1 dB
Propagation Delay	0 %	538 ns
Delay Skew	0 %	< 45 ns

Attenuation-to-Crosstalk Ratio (ACR). Using " pair-to-pair NEXT Loss", all cables should exhibit worst case ACR performance of greater than 15.0 dB in the frequency range of 1 to 80 MHz, and greater than 13.3 dB in the frequency range of 80 to 100 MHz per 100 meter test sample.

Power Sum Attenuation-to-Crosstalk Ratio (PSACR. Using "Power Sum NEXT Loss", all cable should exhibit worst case ACR performance of greater than 12.0 dB in the frequency range of 1 to 80 MHz and greater than 10.3 dB in the frequency range of 80 to 100 MHz per 100 meter test sample. In addition to the requirements listed above, bundled or hybrid cable must also meet the following requirements:

- Be in groupings of 4-pair units.
- Be power sum NEXT tested where any disturbed pair within the hybrid/bundle cable should be 3 dB better than the specified pair-to-pair NEXT loss of a single 4-pair cable of the same category.

Faceplates

All flush mounted faceplates should possess the following characteristics:

- Be applicable to both fiber and copper applications.
- Be available in 1-, 2-, 3-, 4- and 6-port single-gang configurations or 6-, 8- and 12-port double-gang configurations.
- Allow modules to be removed from the front of the faceplate.
- Allow UTP modules to pass through faceplates even after termination.
- Have write on designation labels for circuit identification together with a clear plastic cover.
- Feature easily removable designation label covers which can be removed without use of tools.

- Have as a minimum the standard colors of black, white, gray, ivory, and light ivory.
- Have optional modular furniture adapters available.
- Have designer style faceplates and mounting frames available.
- Have stainless steel versions available with designation label option.
- Have surface mount boxes and standoff rings available for both single and double gang faceplates.
- Be manufactured using UV resistant, high impact thermoplastic to prevent color fading and provide additional durability.
- Must be certified by UL.

Siemon Company MAX Series Faceplates or equivalent recommended

Racks

For rack-mounted installations in a telecommunications room, the installer should use a 19 in equipment rack. The rack should meet or exceed the below characteristics of construction and features:

- Have 3 in by 6 in vertical cable channels as side rails in 7 ft. heights.
- Have channels capable of utilizing and re-locating ten high capacities, reusable hook and loop cable managers provided with rack, and additional managers available in bags of ten.
- Have ten high capacity cable managers provided for the front, side or back of the rack, which can be used for horizontal or vertical cable management and easily twist and lock into place without the use of screws or tools, and have additional managers available in bags of ten.
- Have standard ANSI/EIA-310-C mounting holes having a full 45 RMS on front and back of rails. Cable routing openings should be available in the front and rear of the channels.
- Have ladder channel which acts as a top bracket to easily nest a standard 12 in ladder tray. The channel must have carriage bolt holes for attaching to the ladder system.
- Have available an optional rack top cable tray which manages cable bundles routed above the rack, and eliminates the need for installing a ladder rack for routing cables. The tray is mounted without the need of tools or hardware and includes up to three separate cable paths featuring removable quarter-turn hook and loop cable managers.
- Be available in aluminum with a black finish and utilize black grommets for unused cable openings.

- Have two optional vertical cable management channels, 6in x 7 ft. and 3in x 7 ft, which can be located between racks. The channel should come with cable retainers, which can be hinged left. or right and be located in any position along the channel.
- Have floor mounting holes and a ground lug for 0-6 gauge ground cable provided.

Siemon RS Series Rack System or equivalent recommended

Surface Mounted Raceway System

This specification covers a latching raceway system used for data network, voice, video, and other low-voltage wiring. The latching raceway system should consist of raceway appropriate fittings and device boxes. Latching raceway is to be surface mounted and utilized in dry interior locations only. The system is for low voltage cabling only, 50 Volts or less.

The latching raceway system specified for data network, voice, video, and other low-voltage wiring is be the Uniduct 2700/2900 System as manufactured by The Wiremold Company or equivalent. Systems of other manufacturers may be considered equal if, in the opinion of and the written approval of the engineer.

The latching raceway and all system components must exhibit nonflammable self-extinguishing characteristics, tested to comparable specifications of UL94V-0.

The latching raceway should be manufactured with a co-extruded design of rigid PVC compound with a flexible PVC hinge. The raceway should have a smooth finish, available in ivory, white, black, gray, and brown colors.

The latching raceway should be a one-piece design with a flexible hinge. The cover should open to provide accessibility and latch securely closed. Total width should be 0.75" by 0.38" [19.05mm by 9.652mm] deep with an approximate thickness of .04" [1.01mm]. The raceway should be available in 6' and 8' [1.83m and 2.44m] lengths and be supplied with adhesive tape backing.

A full complement of fittings (2700 Series) must be available including, but not limited to, flat, internal and external elbows, tees, drop ceiling fitting, cover clips, and end caps. They should be manufactured of a rigid PVC compound. The fittings should have a smooth texture, available in ivory, white, black, gray, and brown colors to match the raceway. They should overlap the raceway to hide uneven cuts. A transition fitting should be available to adapt to Uniduct 2800 and 2900 Series latching raceways manufactured by The Wiremold Company or equivalent.

Device boxes should be available for mounting standard devices and faceplates. A communications box should be available to mount voice, video, data, and fiber optic connectors. The communications box should provide a means of storage for fiber optic cable. Device and communication boxes should be

snapped onto a base. They should be manufactured of rigid PVC compound. They should be available in ivory, white, black, gray, and brown colors to match the raceway.

The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP/STP, fiber optic, coaxial, and other cabling types with face plates and bezels to facilitate mounting.

A complete line of preprinted station and port identification labels, snap-in icon buttons, as well as write-on station identification labels, should be available.

Testing

Testing of all newly installed cable channels should be performed prior to system cutover.

Copper Testing

All CAT5e field- testing should be performed with an approved level of IIe or III balanced twisted-pair field test device.

All installed CAT5e channels should perform equal to or better than the minimum requirements as specified by the table below:

Parameter	**100MHz (dB)**
Insertion Loss	24.0 dB
NEXT Loss	30.1 dB
PS NEXT Loss	27.1 dB
ACR	6.1 dB
PS ACR	3.1 dB
ELFEXT	17.4 dB
PS ELFEXT	14.4 dB
Return Loss	10.0 dB
Propagation Delay	548 ns
Delay Skew	50 ns

Category 3, balanced twisted-pair horizontal and backbone cables, whose length does not exceed 90 m (295 ft) for the basic link, and 100 m (328 ft) for the channel, should be 100 percent tested according to ANSI/TIA/EIA-568-B.1. Test parameters include wire map plus ScTP shield continuity (when present), insertion loss, length, and NEXT loss (pair-to-pair). NEXT testing should be done in both directions.

All balanced twisted-pair backbone cables exceeding 90 m (295 ft) or 100 m (328 ft) should be 100% tested for continuity if applications assurance is not required.

CAT5e balanced twisted-pair horizontal and backbone cables, whose length does not exceed 90 m (295 ft) for the basic link, and 100 m (328 ft) for the channel, should be 100 percent tested according to ANSI/TIA/EIA-568-B.1. Test parameters include wire map plus ScTP shield continuity (when present), length, NEXT loss (pair-to-pair), NEXT loss (power sum), ELFEXT loss (pair-to-pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.

Test Equipment Criteria

All balanced twisted-pair field testers should be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate should be provided for review prior to the start of testing. Auto test settings provided in the field tester for testing the installed cabling should be set to the default parameters.

Test settings selected from options provided in the field testers should be compatible with the installed cable under test. A list of compliant field testers and associated test adapters from approved manufacturers has been provided.

- Agilent WireScope 350 or FrameScope 350
- Fluke Networks OMNIScanner,DSP-4000(100,-300), DTX-1200(1800, LT)
- Ideal LT 8100A(155T,600T) LANTEK 6 (7)

Administration and Documentation

Labeling . Horizontal and backbone cables should be labeled at each end. The cable or its label should be marked with its identifier. A unique identifier should be marked on each faceplate to identify it as connecting hardware. Each port in the faceplate should be labeled with its identifier.

A unique identifier should be marked on each piece of connecting hardware to identify it as connecting hardware. Each port on the connecting hardware should be labeled with its identifier.

Drawings. As-built drawings should be supplied by the contractor showing the locations of and identifiers for all of the following:

- Horizontal cable routing and terminations
- Telecommunications outlets/connectors
- Backbone cable routing and terminations

Records. All records should be created by the installation contractor and turned over at the completion of work. The format should be computer-based and should be part of the As-built package. The minimum requirements include:

- Cable records must contain the identifier, cable type, termination positions at both ends, and splice information as well as any damaged pairs/conductors.
- Connecting hardware and connecting hardware position records must contain the identifier, type, damaged position numbers, and references to the cable identifier attached to it.
- Test documentation on all cable types should be included as part of the As-built package.

Reports. All reports should be generated from the computer-based program used to create the records above. These reports should include, but are not limited to:

- Cable reports,
- Cross-connect reports,
- Connecting hardware reports.